

REMARKS FROM J. LEDERBERG REGARDING THE LONG RANGE OBJECTIVES OF THE SPACE PROGRAM AND THE REQUIREMENTS FOR LARGER VEHICLES

We certainly have to focus on our long-range concerns and try to establish the quality and scope of our national commitment. Larger vehicles will be necessary for the following missions of major importance: (1) the retrieval of surface samples from the ^{moon} planets for the kind of detailed investigation that is only possible in the terrestrial laboratory. (2) the propulsion of large instruments for the study of the solar system and of the larger universe a) large optical telescopes with capabilities now perturbed by the earth's atmosphere b) radio telescopes to include the function of detection of galactic communication c) automatic planetary laboratories of which Surveyor is the prototype for the reconnaissance of planetary terrain and for the investigation of sub-surface strata. (3) Manned space flight in vehicles that afford sufficient range maneuverability and navigational and environmental information to enable man to play a critical part in the exploration of the solar system.

At the present time, the use of manned vehicles in the exploration of space is problematical for two main reasons: (1) We do not know how well he can function in the constraints of space flight. (2) There is very little doubt from general physiological considerations and from the biological experiments that have already flown that man is capable, in principle, of being carried on short term voyages. To this extent, the Mercury project is likely to give us much more reassurance as to the correctness of our predictions than vital new knowledge. However, the Mercury project is only the first step in a program that must probe deeper into unpredictable effects, especially of the long term viability of the human passenger in spacecraft environments. The main criticism that might be offered of the Mercury program is that it has been publicized as a vitally important end in itself, whereas it can in fact, make only an extremely limited contribution to the solution of the problem of manned space flight. However, if manned space flight is ever to be accomplished, there must be a start at some point and Mercury can quite profitably be represented in this light. Perhaps the implication should be made quite explicit, therefore, that manned space flight will be an extremely expensive proposition and that the costs of Mercury are only the very first stage expense.

It should be stressed that man is exploring space by the act of extending his sensors into the reaches of the solar system through instrumented space craft. Man plays a vital role in the design and programming of such vehicles and in the reception and interpretation of the data generated by them. In many respects, the man on the ground interpreting the telemetered data and having the resources of the terrestrial laboratory ^{and the insight of his colleagues} will have a far more intimate knowledge of the space that a vehicle is exploring than will the astronaut who accompanies the vehicle. In any case regardless of the utilization of the astronaut, it will be essential to support a strong development of compact instrumentation which is as fully automated as possible. The usefulness of the astronaut will depend to a large measure on the extent to which he is assisted by instrumentation that can furnish environmental and coordinate data to him in a form that he is capable of

*We do not know of any vital operations that cannot be performed, at least in principle, by devices in radio communication with the earth.

interpreting and using. His main advantage may arise from the acceleration of response that is possible when such data are presented to him immediately at the site of investigation rather than having to traverse the long and in some respects, attenuated communication link from the exploration site to the earth and back. Furthermore, the astronaut's usefulness will be greatly amplified by the extent to which he can maintain a volume of useful communication with the earth for consultation and analysis of the data that he acquires. It should, therefore, be apparent that regardless of the attention given to the support of the human passenger, the same intensive effort must be made in the development of instrumentation, automation, and communication techniques. It should also be apparent that the engineering development of these techniques will have enormous byproduct advantages for other scientific and economic purposes.

The importance of man in the exploration of space can perhaps be assessed by considering how much we are able to do with and without his presence on the vehicle. We are optimistic that the major questions that we would want to ask of the solar system can be answered by instrumented techniques. The possible role of man in further investigation may not be so evident until more subtle questions have arisen on the basis of unexpected information obtained during our earlier efforts at the exploration of space. Then, and perhaps only then, are we likely to have cause for regret or complacency if new difficulties supervene that discourage the extension of efforts at manned space flight.

Particularly to be condemned is the attitude that manned space flight is an end in itself. This may be able to serve the emotional interests of a small number of adventurers but we should be looking for deeper motivations to justify the immense commitments of national resources that are involved in the space program. With adequate attention to the understanding of the way that man is indeed exploring space by the extension of his sensory instruments, we may be better able to put this problem in sober perspective. In sum, I would recommend that the strongest support continue to be given to the investigation of the chronic physiological effects of environmental factors likely to be found in space; and with adequate precedent in terrestrial research these experiments should be extended to the space environment. We should keep an open mind with regard to the ultimate utility of the astronaut for the purpose of exploration and should continue in any event to stress the development of the tools that will be needed on the one hand, for the continued retrieval of scientific information by automatic instruments, or on the other, for the support of the more immediate participation of the explorer in the examination of his environment in space.